A SUMMARY OF ON-BOARD MONITORING OF THE CHUB AND WHITEFISH GILL NET FISHERIES FOR INCIDENTAL CATCH, WISCONSIN LAKE MICHIGAN 1996-1999

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Since at least the 1960's, personnel from the Wisconsin Department of Natural Resources (WDNR) have conducted on-board monitoring of commercial fishing activities on Wisconsin Lake Michigan to gather information on the catch of both targeted and incidental (by-catch) species. During the 1980's until 1991, on-board monitoring was done on a fairly regular basis throughout each year. However, from 1991-1997, lack of funding allowed for little more than token monitoring of the fisheries, with minor exceptions.

By the mid 1990's, lakeshore biologists expressed increasing concern about the lack of current information on the composition and extent of the incidental catch in some gill net fisheries. Consequently, during the 1997-99 biennium (July 1997 – June 1999), a project was funded with the objective of gathering year-round information on incidental species in the small mesh gill net chub fishery in the lake and the large mesh gill net fishery for whitefish in waters around northern Door County.

This report is a summary of results from on-board monitoring that was project-funded and occurred from September 1997 through June 1999 as well as monitoring conducted for short term special studies during the winter chub fishery in 1996, 1997, and 1998.

METHODS

During the period September 1997 – through June 1999, WDNR fisheries personnel from the Sturgeon Bay, Mishicot, and Milwaukee field offices monitored on a monthly and somewhat random basis the commercial small mesh gill net fishery for chubs at ports from Washington Island south to the Wisconsin/Illinois border. We also monitored the large mesh gill net fishery for whitefish in the Bay and Lake waters off northern Door County. During each month that the fisheries were active, the goal was to monitor on-board a minimum of one lift out of each of the major ports (Figure 1).

Fishermen were contacted the day prior to a monitoring to make arrangements for the monitor to meet a crew at the dock the following morning. An attempt was made to alternate monitoring of fishers so that no one fisher was monitored excessively compared to other fishers. Similar data was collected by and obtained from U. S. Fish and Wildlife personnel who monitored commercial fishing operations during the same time period in search of unclipped lake trout.

In addition, during January and February 1996, 1997, and 1998 fisheries personnel monitored lifts of chub nets set deeper and shallower than the minimum allowable depth of 60 fathom in the northern and/or southern chub zones and just north of the northern boundary of the southern chub zone. This monitoring was in response to requests for special studies made by some commercial chub fishers. The cost of some of this on-board monitoring was paid for by commercial fishers under contract to WDNR to set and lift nets.

Data collected during each monitored lift included: date, location, effort, number of nights fished, depth of set, fisher license number, pounds of targeted species, number and condition (live or dead) by species of incidental fish caught, total length and fin clips of incidentals, and tag information. An incidental fish was judged live if it was not bleeding profusely and upon return to the water avoided bird predation by quickly swimming downward. Heads from lake trout and chinook salmon with code-wire tags (adipose clipped) were severed from carcasses and saved for later tag removal and decoding. On a few occasions, a fisher lifted more than one gang in a day. In those cases, information from each gang was kept separate and entered as a separate record in the database. Gangs of standard mesh nets set and lifted by the crew aboard the WDNR R/V Barney Devine in conjunction with graded mesh gill net assessments were treated the same as commercial lifts.

Most catch rate (CPE or catch per unit effort) data summaries for incidental species were produced using an application of the FOXPRO database software program. Mean rates of catch per effort (total and dead) in the chub fishery were calculated and grouped by 5-fathom intervals (based on mean depth per lift) for four geographic survey areas: 1 - northern (eastern Door County), 2 - middle (Algoma to north of Port Washington), 3 - south (Port Washington to WI/ILL boarder), and 4 - mid-lake (offshore grids adjacent to the Mid-lake lake trout refuge) (Figure 1). For the lake whitefish gill net fishery, data was pooled for all years and seasons, and summaries were grouped for two geographic areas: northern Green Bay and northern Lake Michigan waters off northern Door County. CPE is expressed as the total number of fish/1000 ft of net/night. Total reported effort information for the chub and lake whitefish fisheries was available from mandatory data provided by licensed commercial fishers and summarized using an application of the ORACLE database program.

Estimates of dead incidental lake trout and chinook in the chub and whitefish fisheries were calculated as follows. For lake trout and chinook salmon in the small mesh gill net chub fishery, mean CPEs of dead fish (weighted by amount of effort monitored at various depths) were calculated for each of three time periods of pooled monitoring data, 1981-85, 1986-90, and 1996-99, for each of the four sampling zones. A weighted mean of means was calculated for the southern chub zone from the middle, southern, and midlake data combined. The mean CPEs of dead fish were then multiplied by the

total reported effort during calendar years in the two chub zones, which coincided closely with the three monitoring periods. For lake trout and chinook in the large mesh gill net whitefish fishery, estimated incidental kill figures for 1986 through 1993 were taken from the 1998 whitefish report. Incidental kill estimates for 1994 through 1999 were based on mean CPEs from pooled monitoring data from 1996-99, applied in a manner similar to the procedures used for the chub fishery.

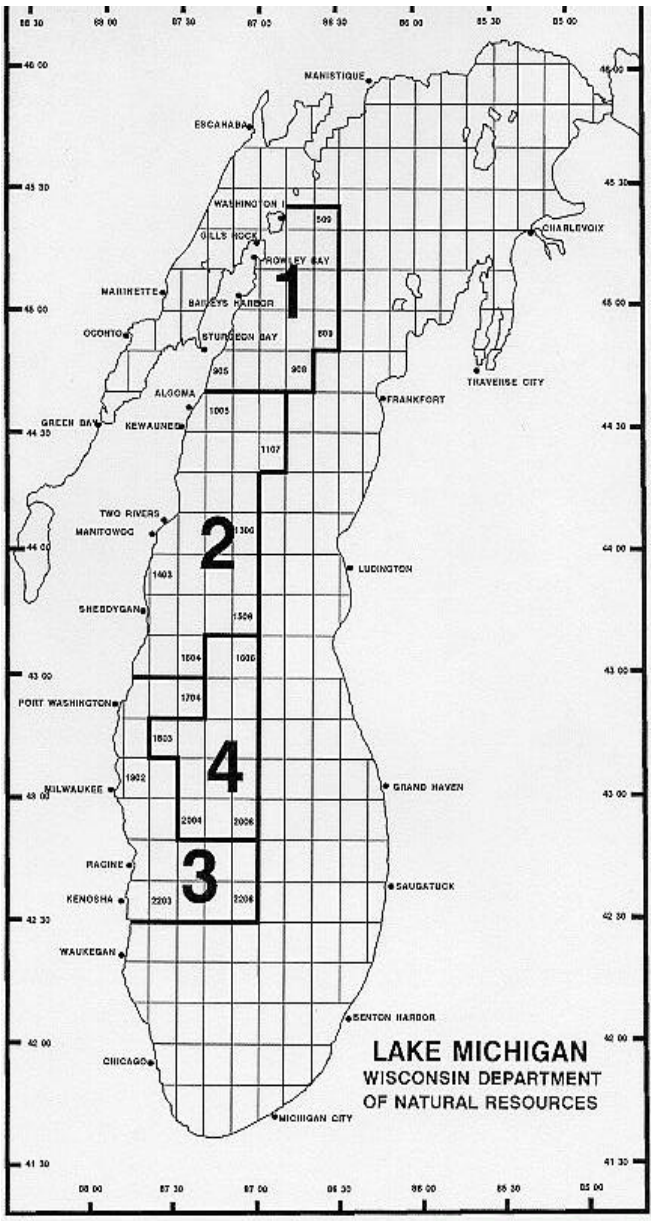


Figure 1. Chart showing location of major commercial fishing ports and numbered geographic areas sampled during commercial monitoring of the small mesh gill net fishery for chubs, Wisconsin Lake Michigan 1996-1999. Selected grids are numbered to aid in locating specific grids listed in Appendix A.

RESULTS AND DISCUSSION

SMALL-MESH GILL NET CHUB FISHERY

Number and Distribution of Lifts Monitored

From January 1996 through June 1999, a total of 201 lifts of separate gangs of standard mesh chub nets were monitored on-board by fisheries staff (Table 1). The total included 194 commercial gangs and 7 gangs lifted by the crew of the Barney Devine in conjunction with graded mesh assessments of the chub population.

Lifts of chub nets were monitored most often in the middle area and during the winter period (Table 1). The middle area contains many of the busiest year-round chub fishing ports from Algoma to Sheboygan (Figure 1). The winter period was intensively monitored due to special studies concerning depth and area restrictions that occurred in 1996 - 1998. Lifts were monitored in 30 different grids at least once and in some quite intensively due to the large amount of fishing activity (Appendix A).

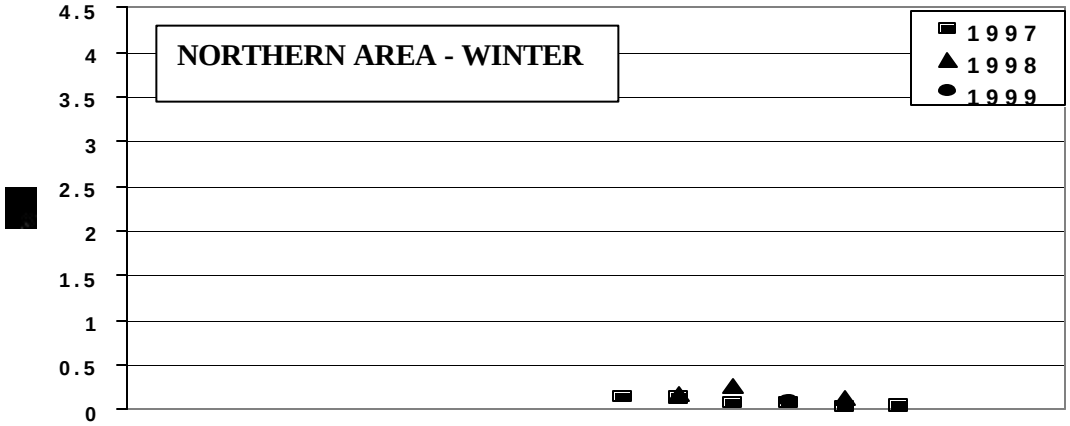
Table 1. Distribution of monitored lifts of separate gangs of chub nets, by area and season, 1996-1999.

	WINTER	SPRING	SUMMER	FALL	TOTALS
NORTH	21	5	8	9	43
MIDDLE	49	28	20	18	115
SOUTH	16	5	5	13	39
MID LAKE	1	1	1	1	4
TOTALS	87	39	34	41	201

Catch Rates of Lake Trout By Area

Lake trout CPEs in the northern, middle, and southern areas, all seasons and years combined, generally followed a similar pattern of declining catch rates with increasing water depth (Figure 2 and Appendix B). In all areas except the mid-lake, CPEs were usually highest at depths less than approximately 240 feet, in some cases exceeding 3 fish/1000 feet/night. CPEs at depths greater than 240 feet were usually less than 0.5 fish, with gradually declining CPEs as depth increased. In the mid-lake area CPEs were substantially higher at greater depth compared to the other three areas.

FIGURE 2. Mean total catch rates (number/1000 feet/night) of lake trout captured in monitored lifts of commercial (standard mesh) chub nets in four geographic sampling areas by depth increment, season, and year. Each symbol on each chart represents the catch rate of one monitored lift at a depth increment or the mean of more than one catch rate, if multiple lifts were monitored at the same increment. See Appendix C for sample sizes by year, geographic sampling area, season, and depth increment.


NORTHERN AREA - WINTER
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1998
1999
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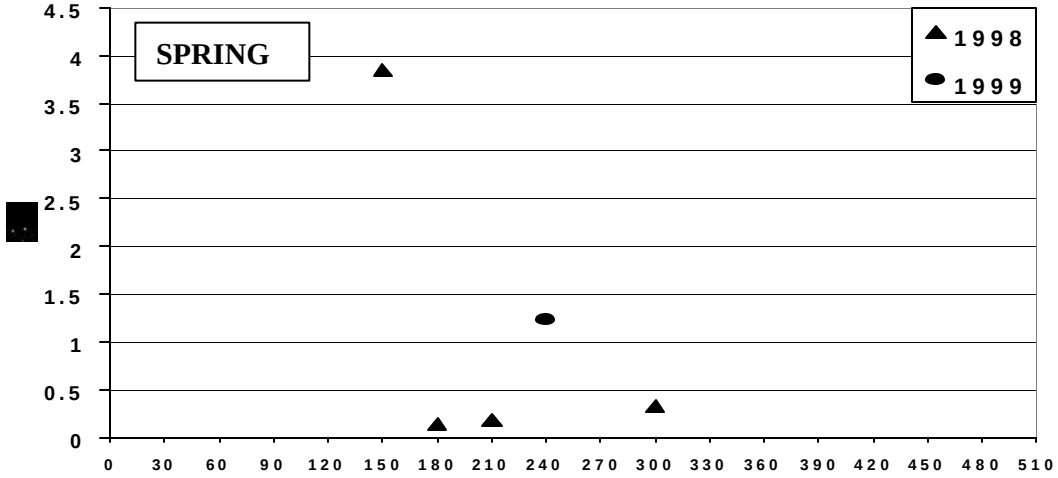
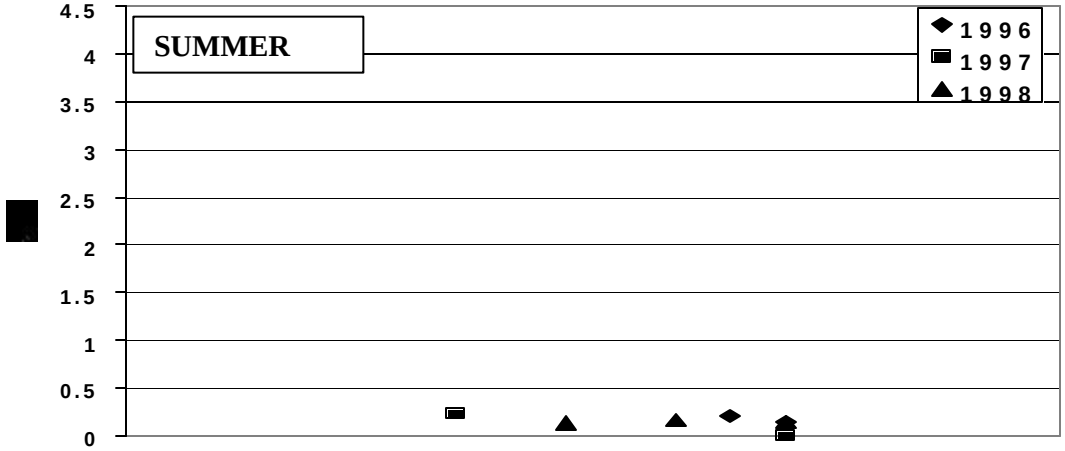
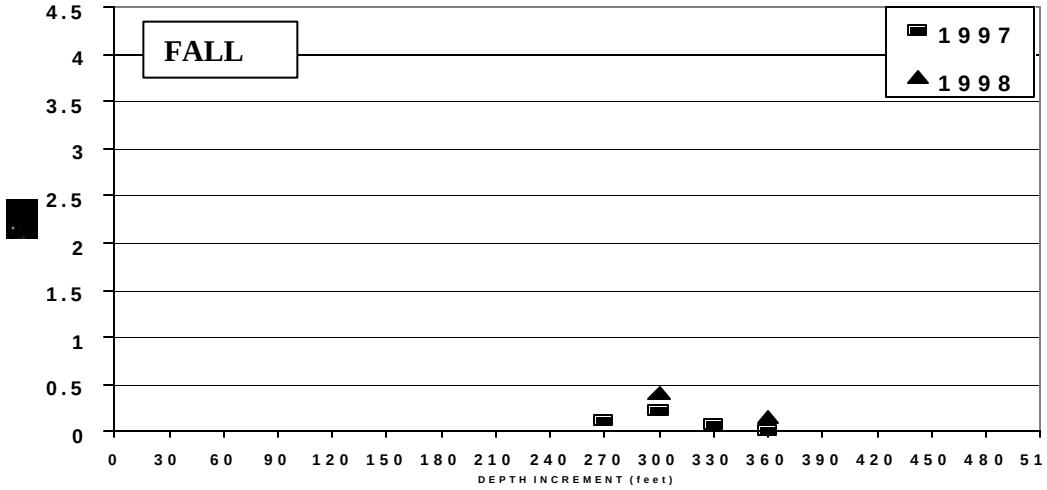
4
3.5
3
2.5
2
1.5
1
0.5
0


SPRING
1998
1999
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0 30 60 90 120 150 180 210 240 270 300 330 360 390 420 450 480 510


SUMMER
1996
1997
1998
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0


FALL
1997
1998
4.5
4
3.5
3
2.5
2
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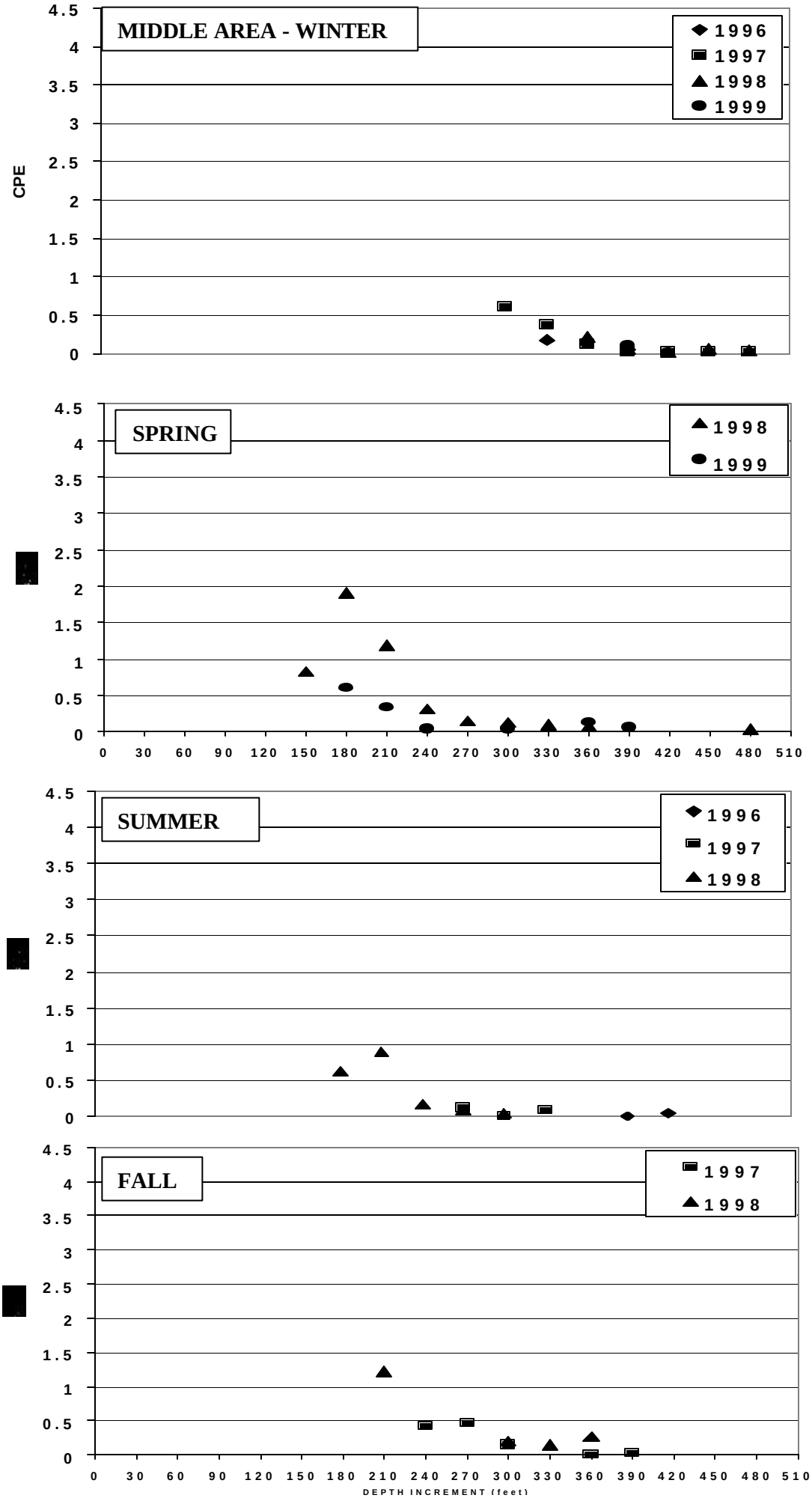
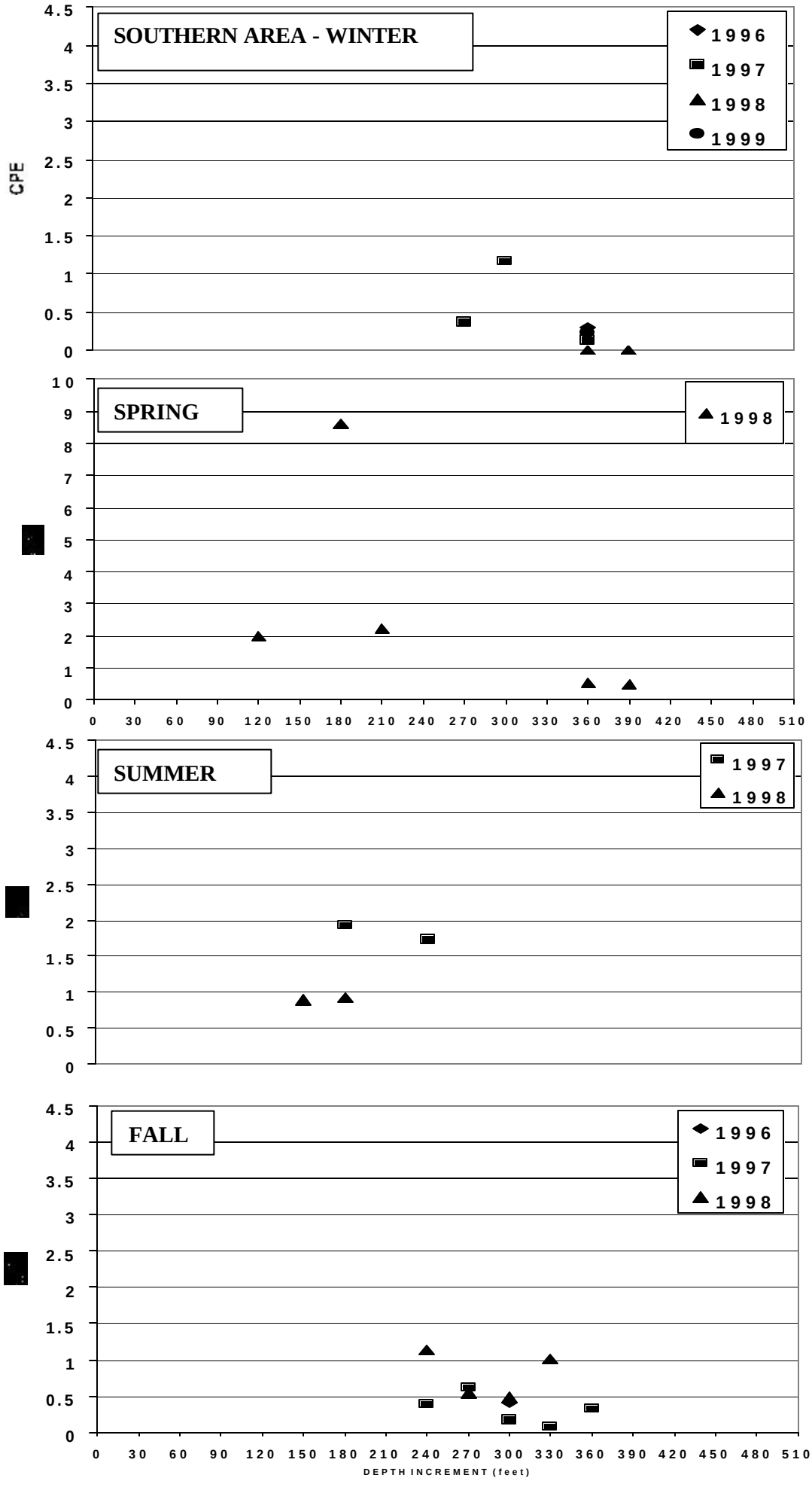
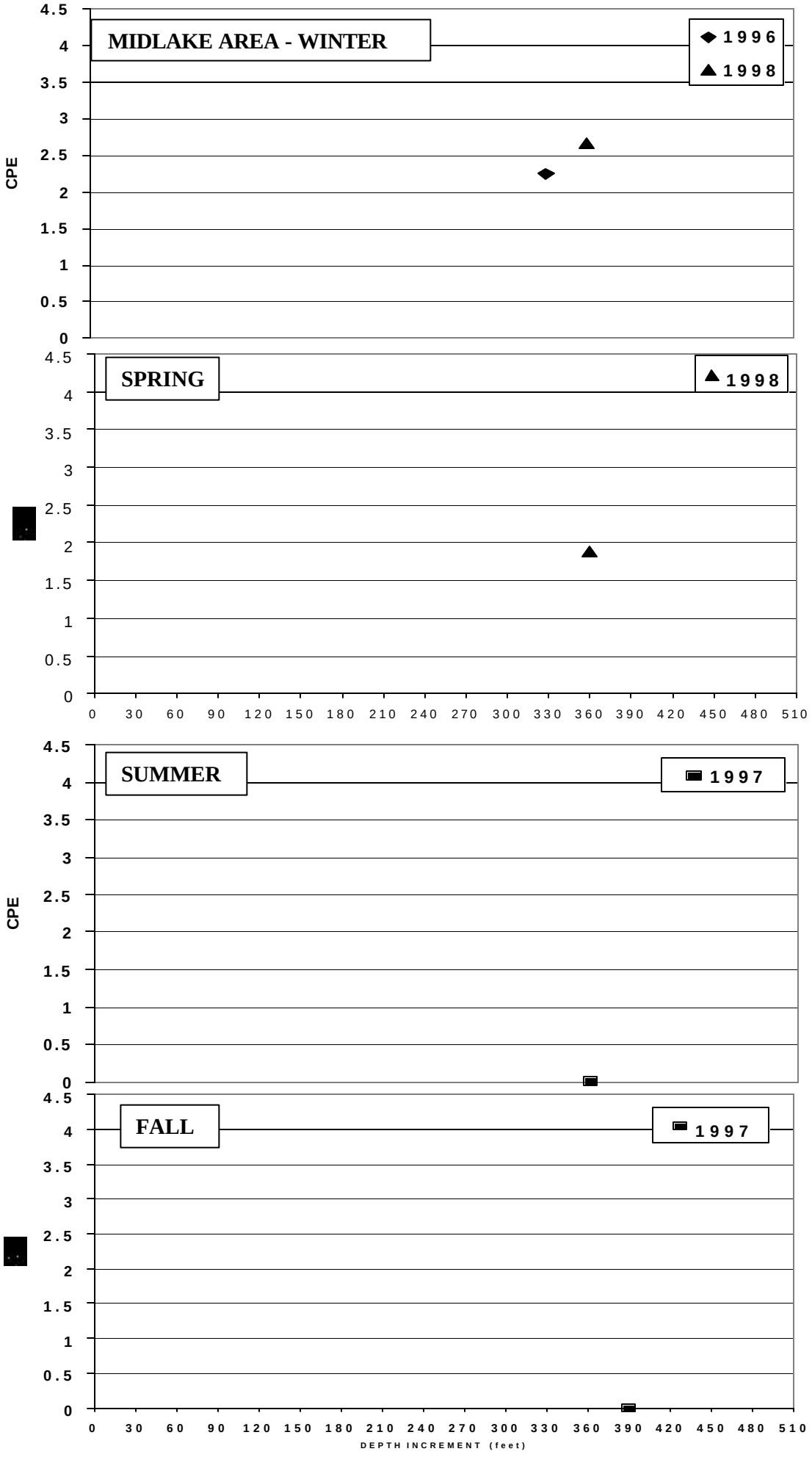
1
0.5
0
0 30 60 90 120 150 180 210 240 270 300 330 360 390 420 450 480 510
DEPTH INCREMENT (feet)


MIDDLE AREA - WINTER
1996
1997
1998
1999
CPE
SPRING
1998
1999
SUMMER
1996
1997
1998
FALL
1997
1998
0 30 60 90 120 150 180 210 240 270 300 330 360 390 420 450 480 510
DEPTH INCREMENT (feet)


SOUTHERN AREA - WINTER
1996
1997
1998
1999
CPE
SPRING
1998
SUMMER
1997
1998
FALL
1996
1997
1998
0 30 60 90 120 150 180 210 240 270 300 330 360 390 420 450 480 510
DEPTH INCREMENT (feet)


MIDLAKE AREA - WINTER
1996
1998
SPRING
1998
SUMMER
1997
FALL
1997
CPE
CPE
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0 30 60 90 120 150 180 210 240 270 300 330 360 390 420 450 480 510
DEPTH INCREMENT (feet)

In general, CPEs were lowest in the northern area compared to the other three geographic areas (Figure 2; Appendix B). There were also some differences in CPEs seasonally within areas. In the northern area, CPE was less than 0.5 at all depths monitored seasonally except in spring when CPE rose occasionally above 1.0 at some depths 240 feet or less (Figure 2).

In the middle area CPEs above 0.5 were found during all seasons. The highest CPEs occurred during spring at depths less than about 240 feet, similar to observations in the northern area.

The highest CPEs found in the four survey areas occurred in the southern area and seasonally were highest in spring and summer, when depths fished were mostly 240 feet or less. However, even at depths greater than 240 feet, CPEs were often higher compared to CPEs in the northern and middle areas at similar depths.

CPEs in the mid-lake area during winter and spring were high but were zero during summer and fall. This area had the least amount of monitoring, which always occurred at depths greater than 300 feet. The proximity of these grids to the intensively stocked Midlake lake trout refuge could be the main reason for the high catch rates.

Size Distribution of Incidental Lake Trout

The majority of incidental lake trout measured on monitored lifts, all years, seasons and areas combined, were less than 500 mm (20 inches) total length (Figure 3).

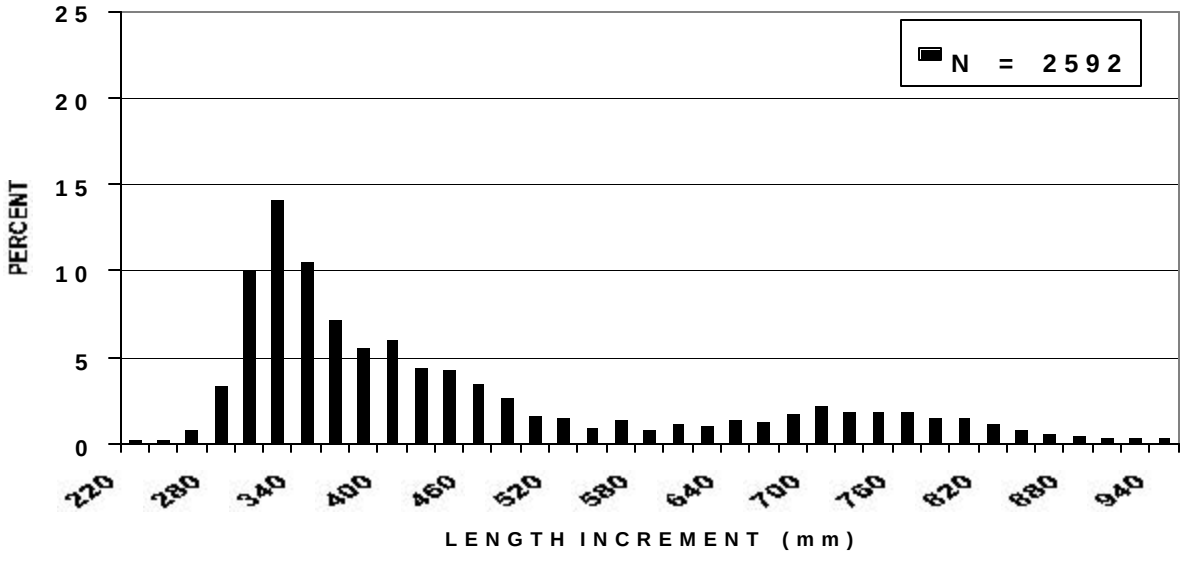


Figure 3. Length frequency distribution of lake trout caught incidentally and observed in chub nets during onboard monitoring, all seasons and areas combined, 1996-1999.

Lake trout less than 500-mm long range in age from 2 to 5 years-old and most are sexually immature.

Mortality of Lake Trout in Nets

Overall, the percent of dead lake trout in nets at time of lifting was lowest in the northern area (55%) but higher and similar in the middle (67%), south (66%), and mid-lake (68%) areas (Table 2). By season, percent mortality in the northern area was usually lower compared to the other three areas. Since number of nights fished per gang was actually somewhat higher in the northern area (5.0) compared to the other three areas (4.8, 4.4, and 4.4), the lower mortality rate in the north cannot be attributed to shorter net soak-time. Also, the criteria for determining condition (live or dead) was clearly defined to help minimize subjectivity and many of the personnel monitoring lifts in the northern area also did so in the middle area. Regardless, the influence of some subjectivity by personnel in determining condition as a partial explanation for this difference in mortality cannot be ruled out. I do not have another explanation.

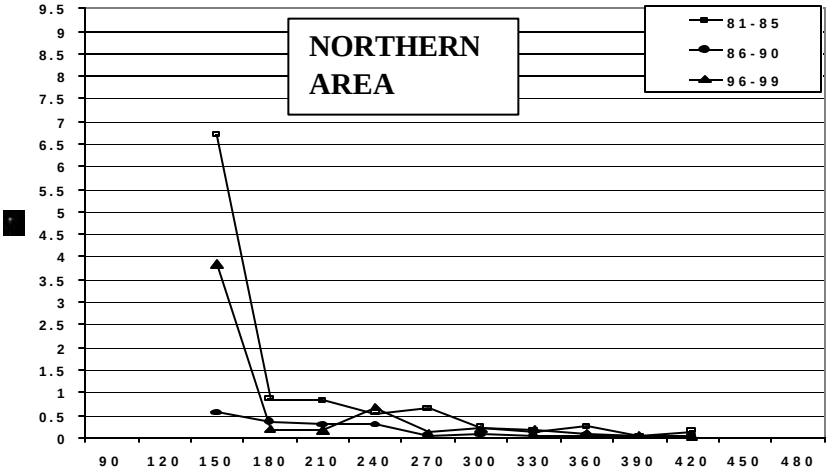
Table 2. Summary of lake trout percent mortality in chub nets by season and geographic area, 1996-1999.

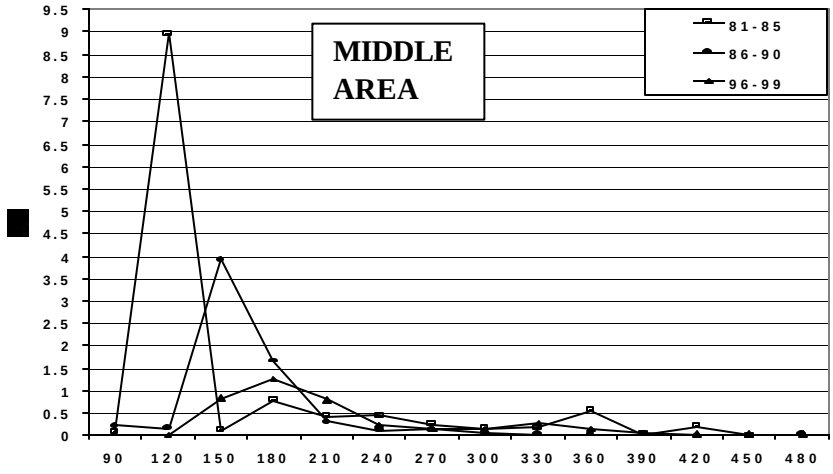
Area												
Season	**North**			**Middle**			**South**			**Mid-lake**		
	Total	**Dead**	**%**	**Total**	**Dead**	**%**	**Total**	**Dead**	**%**	**Total**	**Dead**	**%**
Winter	125	74	59	399	260	65	295	204	69	263	183	70
Spring	244	130	53	415	308	74	363	243	67	79	50	63
Summer	23	12	52	149	76	51	242	154	64	0	0	0
Fall	64	34	53	128	82	64	287	179	62	0	0	0
Total	456	250		1091	726		1187	780		342	233	

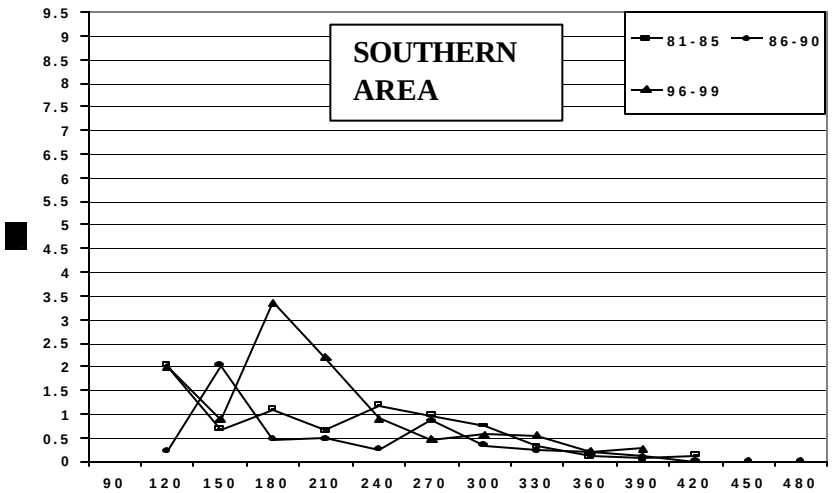
Historical Trends in Incidental Catch Rates of Lake Trout

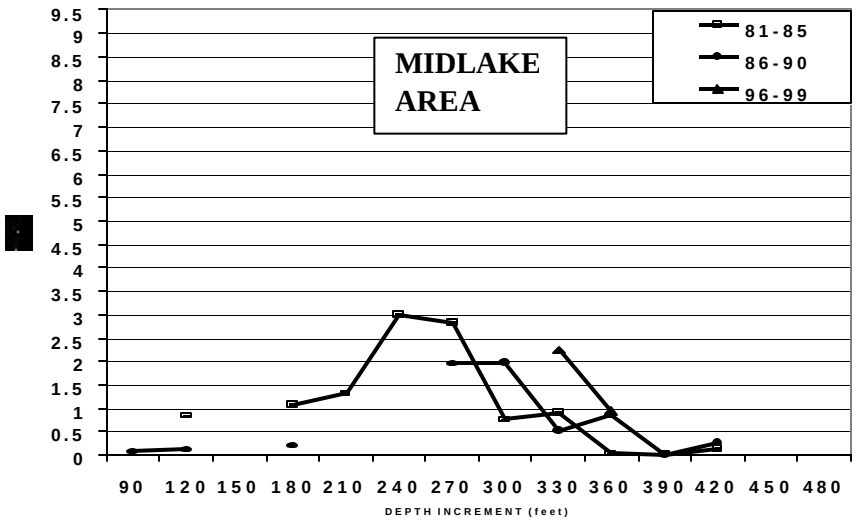
A comparison of total catch rates of lake trout from monitored lifts during three time periods since 1981 show similar trends among periods in each of the four survey areas (Figure 4; Appendix D). In the northern area the highest and most variable catch rates generally occurred during each of the three periods at depths less than 180 feet and in the middle area at depths less than 210 feet. In contrast, catch rates in the southern area generally were relatively high and variable at depths less than 330 feet and in the midlake area at depths less than about 360 feet.

Figure 4. Comparison of recent and historical trends in mean total catch rates (number/1000 feet/night) of lake trout by depth increment in commercial chub nets during three time periods of onboard monitoring – 1981-85, 1986-90, and 1996-99, with all seasons and years pooled for each period. Each symbol on each chart represents the catch rate of one monitored lift at a depth increment or the mean of more than one catch rate, if multiple lifts were monitored at the same increment.


NORTHERN AREA
81-85
86-90
96-99
9.5 9 8.5 8 7.5 7 6.5 6 5.5 5 4.5 4 3.5 3 2.5 2 1.5 1 0.5 0
90 120 150 180 210 240 270 300 330 360 390 420 450 480


MIDDLE AREA
81-85
86-90
96-99
9.5 9 8.5 8 7.5 7 6.5 6 5.5 5 4.5 4 3.5 3 2.5 2 1.5 1 0.5 0
90 120 150 180 210 240 270 300 330 360 390 420 450 480


SOUTHERN AREA
81-85
86-90
96-99
9.5 9 8.5 8 7.5 7 6.5 6 5.5 5 4.5 4 3.5 3 2.5 2 1.5 1 0.5 0
90 120 150 180 210 240 270 300 330 360 390 420 450 480


MIDLAKE AREA
81-85
86-90
96-99
9.5 9 8.5 8 7.5 7 6.5 6 5.5 5 4.5 4 3.5 3 2.5 2 1.5 1 0.5 0
90 120 150 180 210 240 270 300 330 360 390 420 450 480
DEPTH INCREMENT (feet)

Trends in Estimated Incidental Kill of Lake Trout

The total annual estimated kill of lake trout in the chub fishery has varied considerably since the fishery reopened in 1979, peaking at an estimated 81,600 fish in 1984 (Table 3; Figure 5). Most of the kill occurs in the southern zone. The estimated annual kill has declined steadily since 1993, averaging about 31,000 fish annually since then. In the southern zone (reopened in 1979), the annual estimated kill peaked in 1988 at about 74,500 but has declined substantially since 1993, averaging about 28,4000 fish annually since then. In the northern chub fishing zone (reopened in 1981), the annual estimated kill peaked at about 11,500 fish in 1983, but also has declined since 1993, averaging about 3,200 lake trout annually since then. In both zones, the decline in incidental kill has been accompanied by a simultaneous decline in effort fished (Appendix E).

Table 3. Annual estimated incidental kill of lake trout in the commercial chub fishery, total and by chub fishing zone, 1979-99.

AREA	YEAR											
	77	78	79	80	81	82	83	84	85	86	87	88
NORTH					8193	5772	11530	10237	5345	4715	4669	5616
SOUTH			29335	50472	41873	37099	45100	71430	75878	44157	41309	74568
TOTAL			29335	50472	50066	42871	56630	81667	81223	48872	45978	80184
	YEAR											
	89	90	91	92	93	94	95	96	97	98	99	
NORTH	5548	5512	6334	7674	10702	5772	3760	3240	3082	2138	1179	
SOUTH	61526	52823	57788	51657	54446	37156	30547	29246	30120	25332	26743	
TOTAL	67074	58335	64122	59331	65148	42928	34307	32486	33202	27470	27922	

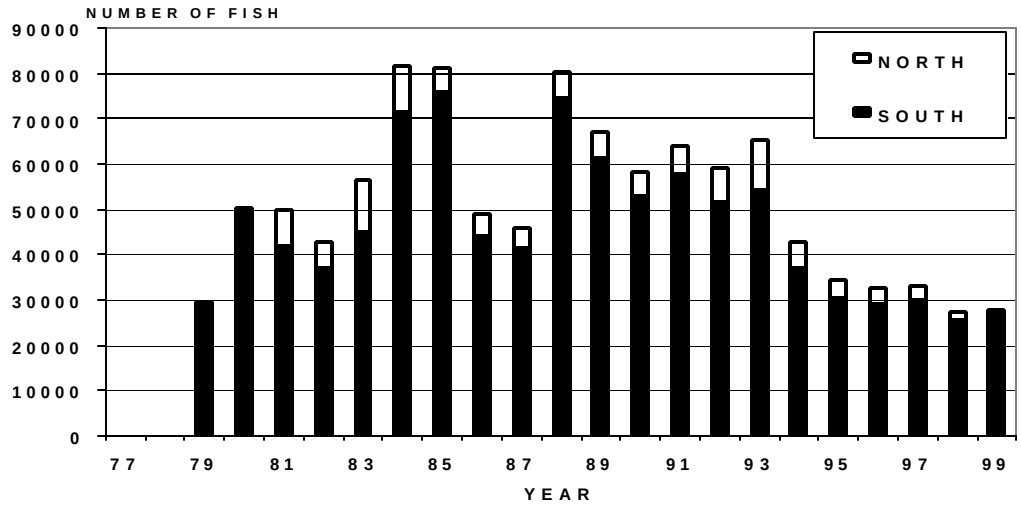


Figure 5. Estimated annual incidental kill of lake trout in the Wisconsin commercial chub fishery, 1977-99.

Incidental Catch Rates of Chinook Salmon

Chinook salmon catch rates in all depths and geographic areas monitored were similar and less than 0.5 fish (Figure 6). In contrast to the substantial increase in incidental catch of lake trout at depths below 240 (Figure 2), chinook catch rates remained uniformly low through all depth ranges monitored.

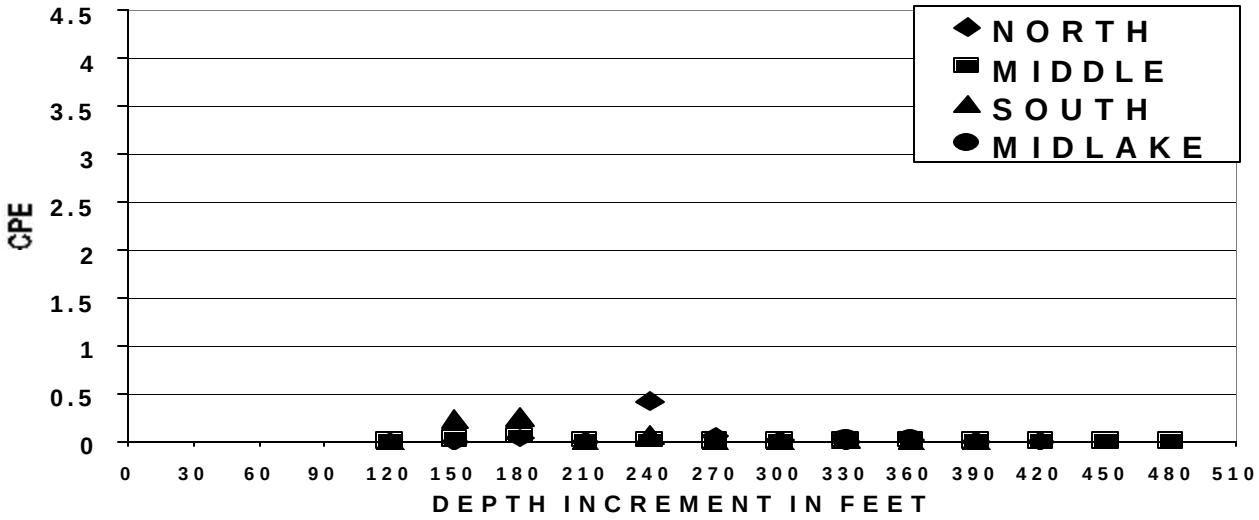


Figure 6. Catch rates of chinook salmon captured incidentally in monitored lifts of commercial chub nets, 1996 – 1999.

Most of the chinook caught incidentally in chub nets were less than 700 mm (28 inches) in length, which equates to ages 0 or 1+ (Figure 7).

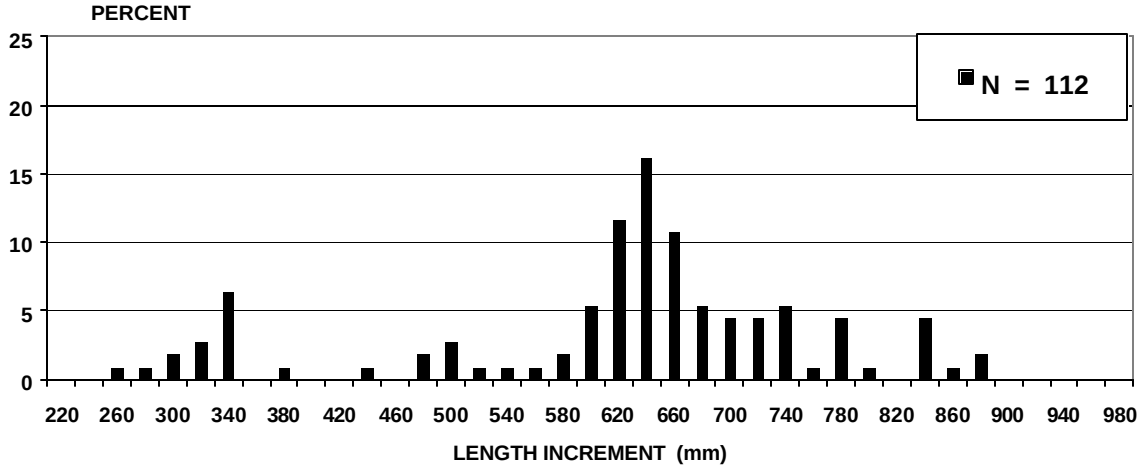


Figure 7. Length frequency of chinook caught incidentally in monitored lifts of chub nets, all areas combined, 1996-1999.

Trends in Incidental Kill of Chinook

The total annual estimated incidental kill of chinook salmon in the chub fishery has declined substantially during the past decade from about 8,000 in 1993 to less than 2,000 in 1999 (Figure 8). In the northern area the estimated kill declined from about 2,500 in 1993 to about 150 in 1999, the lowest level during this period. For the southern area the decline was from a high of about 5,500 in 1993 to about 1,700 in 1999. Overall, the percent of dead chinook in chub nets at time of lifting exceeded 95%.

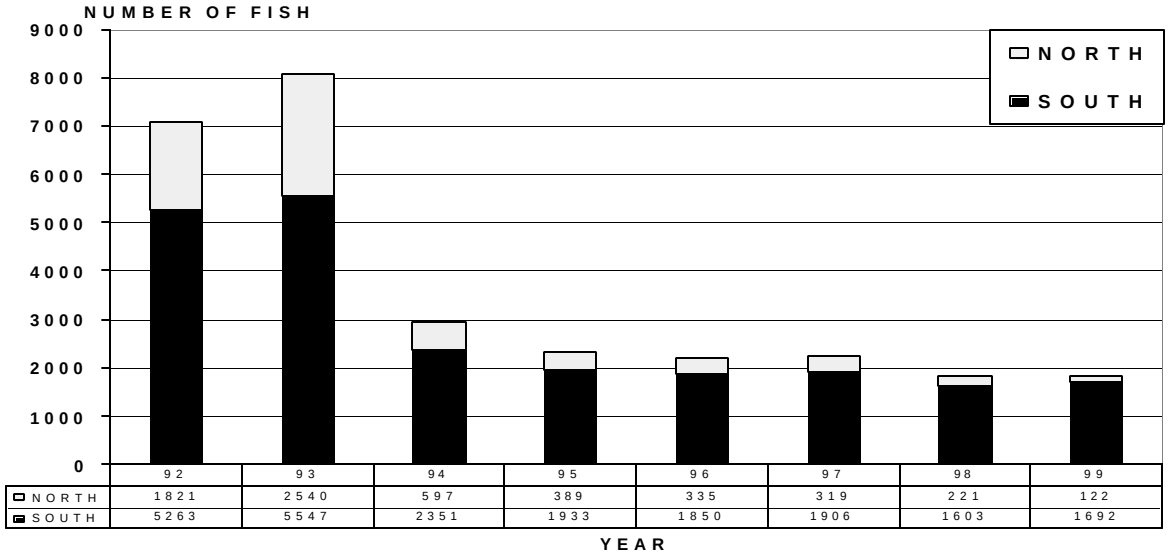


Figure 8. Annual estimated incidental kill of chinook salmon in the northern and southern chub fishing zones, 1992-1999.

Other Incidental Fish Species Captured

In addition to lake trout and chinook salmon, twelve other fish species were captured incidentally in varying numbers in monitored lifts of small mesh chub gill nets. (Table 4). Burbot and juvenile lake whitefish were the only other species caught in relatively substantial numbers. Since not all monitors kept accurate counts of small incidental species like alewife and sculpin, the numbers for such species should be considered conservative at best.

Table 4. Summary of incidental fish species observed during monitored lifts of small and large mesh gill nets, all areas and years combined.

SPECIES	Small Mesh	Large Mesh
Alewife *Alosa psuedoharengus*	1609	
Bloater chub *Coregonus hoyi*		94
Brown trout *Salmo trutta*	1	20
Burbot *Lota lota*	213	991
Chinook salmon *Oncorhynchus tshawytscha*	143	128
Coho salmon *Oncorynchus kisutch*	1	2
Fourhorn sculpin *Myxocephalus quadricornis*	8	
Gizzard shad *Dorosoma cepedianum*		435
Lake sturgeon *Acipenser fulvescens*	1	
Lake trout *Salvelinus namaycush*	3076	945
Lake whitefish *Coregonus clupeaformis*	218	
Longnose sucker *Catostomus catostomus*		96
Round whitefish *Prosopium cylindraceum*	29	10
Slimy sculpin *Cottus cognatus*	2	
Rainbow smelt *Osmerus mordax*	41	
Splake	1	1
Walleye *Stizostedion vitreum vitreum*		8
Yellow perch *Perca flavescens*	4	

LARGE MESH GILL NET LAKE WHITEFISH FISHERY

Number and Distribution of Lifts Monitored

From January 1996 through June 1999, a total of 40 lifts of separate gangs of commercial large mesh gill net set for lake whitefish were monitored by WDNR staff (Table 5). The tota included 12 lifts monitored in northern Green Bay and 25 lifts of bottom gill nets and 3 float gill nets monitored in northern Lake Michigan. More lifts were monitored in the lake because it is the area more intensively fished with large mesh gill nets during most of the year.

Table 5. Number and location of lifts of separate gangs of commercial large mesh gill net monitored by fisheries staff, 1997 – 1999.

	AREA	
GEAR TYPE	**N Green Bay**	**N Lake Michigan**
Bottom Gill Net	12	25
Floating Gill Net	0	3

Incidental Lake Trout Catch Rates By Area

Lake trout CPEs in large mesh gill nets fished on the bottom in the Lake, all years combined, were high at all depths monitored (Table 6; Figure 9). Mean CPE in float nets in the Lake was lower in comparison, perhaps due in part to lake trout being more bottom than surface oriented. CPE was lowest in bottom nets set in the Bay due primarily to the cessation of lake trout stocking there after 1979.

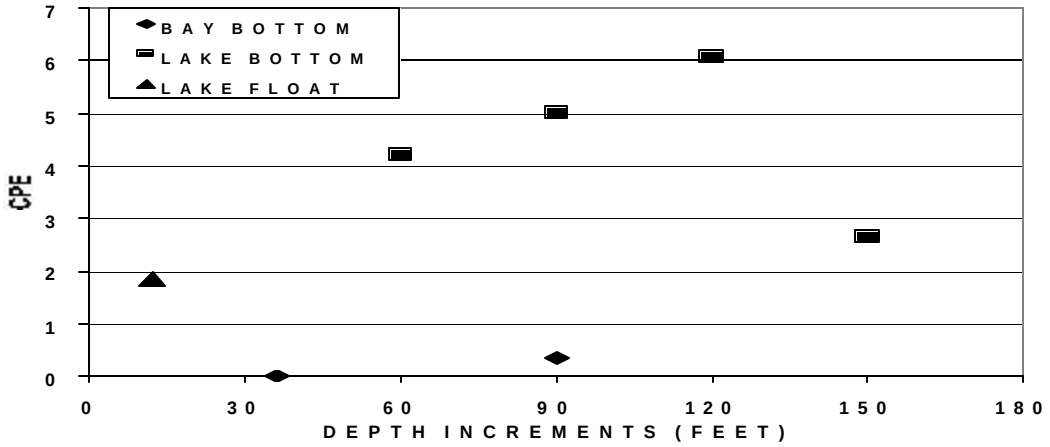


Figure 9. Catch rates of lake trout caught incidentally in monitored lifts of commercial large mesh gill nets, northern Green Bay and Lake Michigan, 1996 – 1999.

Table 6. Summary of catch rates of lake trout and chinook salmon in large mesh gill nets by geographic area and depth increment.

DEPTH INCREMENT (Feet)	CATCH RATES							
	N GREEN BAY				N LAKE MICHIGAN			
	BOTTOM		FLOAT		BOTTOM		FLOAT	
	Lake trout	Chin	Lake trout	Chin	Lake trout	Chin	Lake trout	Chin
0 – 11							1.85	0.25
12 – 23								
24 – 35					0.56	0.0		
36 – 47	0.0	0.0						
48 – 59								
60 – 89					4.20	0.0		
90 – 119	0.34	0.83			5.00	0.06		
120 – 149					6.06	0.04		
150 – 179					2.65	1.25		
180 – 209								

Size Distribution of Incidental Lake Trout

The majority of incidental lake trout observed on monitored lifts of large mesh gill nets during 1997-99, all areas and seasons combined, were greater than 500 mm (20 inches) in total length (Figure 10). Most of the lake trout probably ranged in age from 4 to 7-years-old. This is in contrast to the smaller, younger lake trout captured in small mesh gill nets set for chubs.

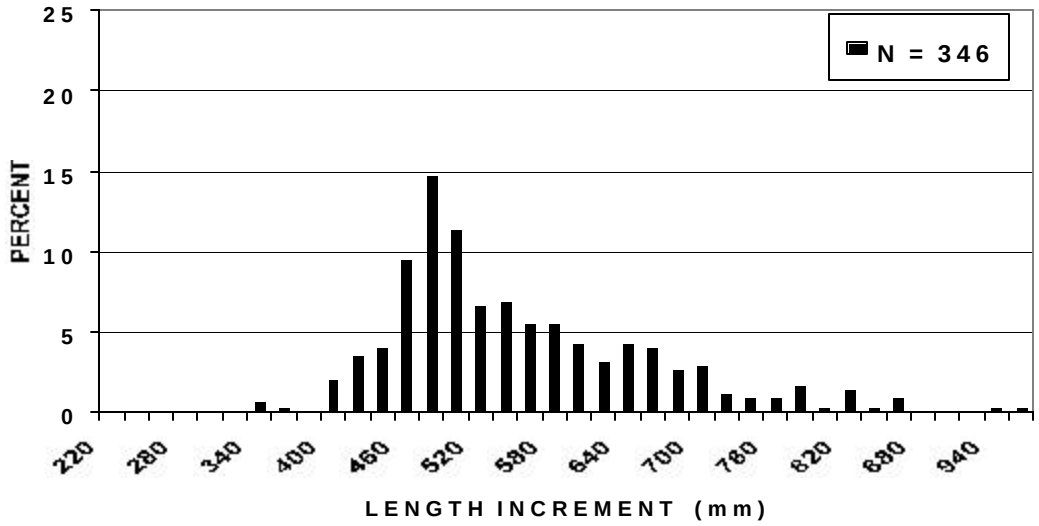


Figure 10. Length frequency of lake trout caught in monitored lifts of large mesh gill net, northern Green Bay and Lake Michigan data combined, 1996- 1999.

Lake Trout Mortality in Nets

Overall, the percent of dead lake trout in nets at time of lifting in both areas was less than 50%, all years combined (Table 7). Mortality in large mesh gill nets was substantially less compared to that in small mesh chub nets. The difference is probably due in part to less soak time between lifts of large mesh gill nets (1-2 nights vs 3-6 nights) and the ability of the predominantly larger trout in these nets to survive longer compared to predominantly smaller trout in chub nets.

Table 7. Percent mortality of lake trout caught incidentally in monitored lifts of large mesh gill net in the waters off Door County, 1996 and 1999.

AREA	TOTAL NUMBER	TOTAL DEAD	PERCENT MORTALITY
Lake (bottom)	881	311	35
Lake (float)	35	12	34
Bay (bottom)	29	14	48

Chinook Incidental Catch in Large Mesh Gill Nets

The incidental catch rate for chinook in large mesh gill nets was less than 1.5 fish/1000 feet in all depths and areas monitored (Figure 11),which was substantially lower compared to incidental catch rates in the same gear for lake trout (Figure 9).

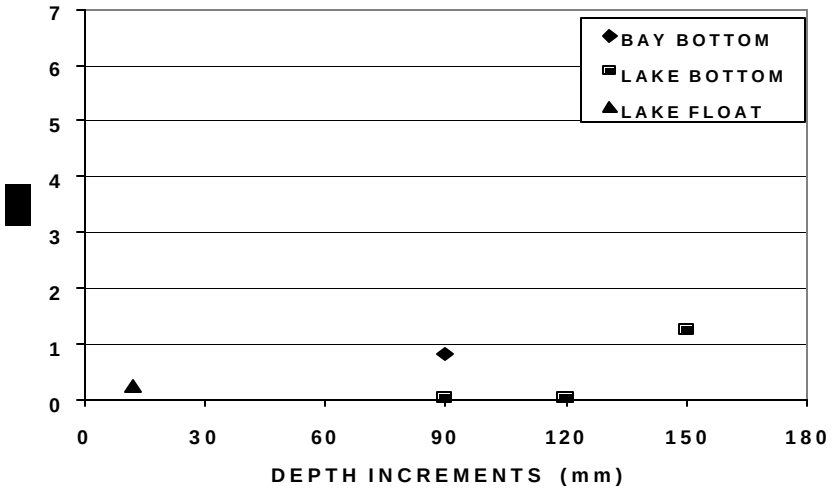


Figure 11. Catch rates of chinook salmon caught incidentally in monitored lifts of large mesh gill nets, northern Green Bay and Lake Michigan data combined, 1996 – 1999.

The majority of chinook captured in large mesh gill nets were less than 600 mm in length (Figure 12) and ranged in age from 0 - 1+.

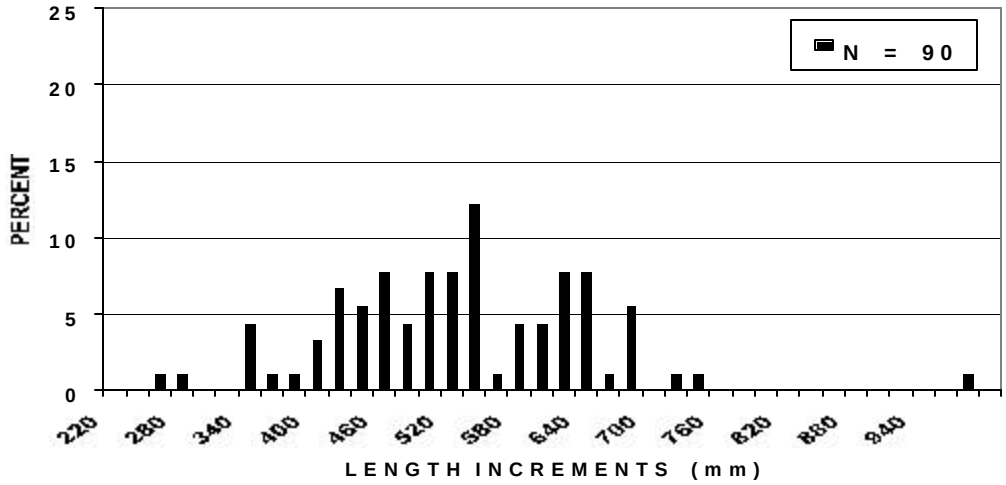


Figure 12. Length frequency of chinook salmon caught incidentally in monitored lifts of large mesh gill net, northern Green Bay and Lake Michigan data combined, 1996-1999.

Trends in Incidental Kill of Lake Trout and Chinook

The estimated total annual incidental kill of lake trout in large mesh gill nets increased substantially during 1998 and 99 compared to a much lower trend during most of the 1990s (Figure 13). On average 11,700 fish were killed annually in the Bay and Lake combined during the last two years compared to an annual average of about 4,800 from 1990 through 1997. The increased kill occurred in the Lake off Door County and was due primarily to the substantial increase in effort fished in that same area the past two years (Appendix E).

During most of the 1990s, both effort and incidental kill in the Lake had declined substantially compared to the previous decade. Effort and incidental kill of lake trout in the Bay declined gradually during the 1990s and has remained at relatively low levels compared to the Lake fishery. Yearling lake trout have not been stocked in Wisconsin waters of Green Bay since 1979 compared to the continuous annual stocking that has occurred in Lake waters.

The estimated incidental kill of chinook in large mesh gill nets during the 1990s remained relative low and stable, averaging about 3,900 fish annually, Bay and Lake combined (Figure 14). The majority of the kill occurred in northern Green Bay. The large increase in effort fished in the Lake during 1998 and 1999 did result in an increased kill of chinook but on a much smaller scale than for lake trout. The incidental catch rate of chinook in large mesh nets in the Lake is much lower compared to that for lake trout (Table 7).

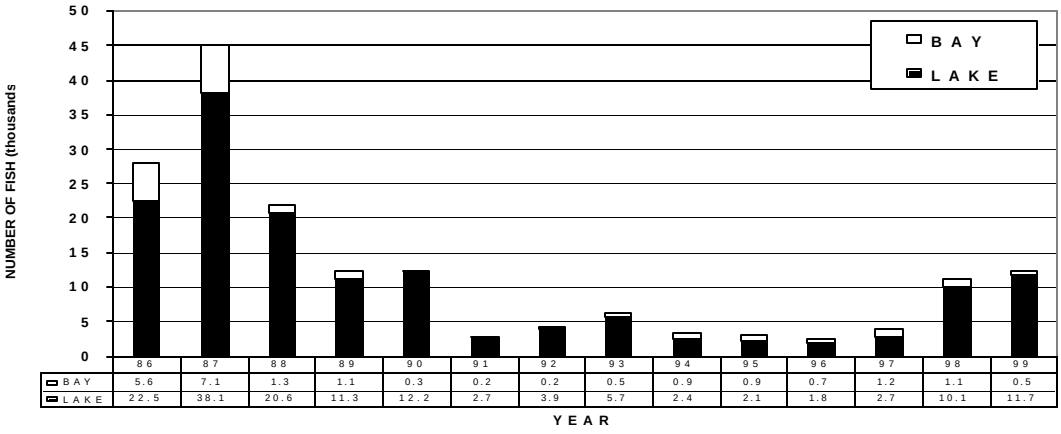
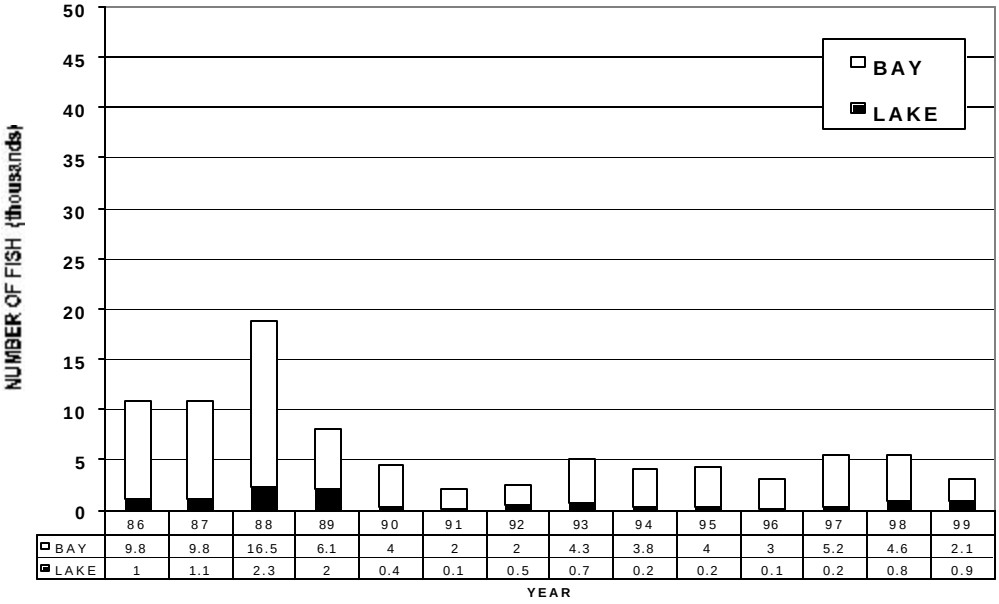


Figure 13. Estimated incidental kill of lake trout in large mesh gill nets set in Green Bay and Lake Michigan waters off northern Door County, 1986-1999.



	86	87	88	89	90	91	92	93	94	95	96	97	98	99
BAY	9.8	9.8	16.5	6.1	4	2	2	4.3	3.8	4	3	5.2	4.6	2.1
LAKE	1	1.1	2.3	2	0.4	0.1	0.5	0.7	0.2	0.2	0.1	0.2	0.8	0.9

Figure 14. Estimated incidental kill of chinook salmon in large mesh gill nets set in Green Bay and Lake Michigan waters off northern Door County, 1986-1999.

Other Species Caught Incidentally

In addition to lake trout and chinook, nine other fish species were caught incidentally in monitored lifts of large mesh gill net set for lake whitefish (Table 4). Burbot and gizzard shad were the only other species caught in substantial numbers.

SUMMARY AND CONCLUSIONS

1. From January 1996 through June 1999 a total of 201 separate gangs of standard small mesh commercial nets set for chubs were monitored onboard during lifting by fisheries personnel.

2. In chub nets, lake trout CPEs in the northern, middle, and southern survey areas generally followed a similar pattern of declining catch rates with increasing water depth.

3. The highest CPEs found in the four survey areas occurred in the southern area.

4. The majority of incidental lake trout in chub nets were less than 500 mm (20 inches), most of which ranged in age from 2 to 5-years-old.

5. Overall, percent mortality of dead lake trout in chub nets at time of lifting was lowest in the northern area (55%) but higher and similar in the middle (67%), south (66%), and midlake areas (68%).

6. A comparison of total catch rates of lake trout in chub nets from monitored lifts during three time periods since 1981 show similar trends among periods in each of the four survey areas.

7. The estimated total annual kill of lake trout in the chub fishery has varied considerably since the fishery reopened in 1979, peaking at 81,600 fish in 1984. Most of the incidental kill occurs in the southern chub zone. Incidental kill of lake trout has declined substantially in the northern and southern zones since 1993.

8. Chinook salmon incidental catch rates at all depths and survey areas monitored were similar and consistently less than 0.5 fish.

9. Most of the chinook caught incidentally in chub nets were less than 700 mm (28 inches) in length, which equates to ages 0 or 1+.

10. The estimated total annual incidental kill of chinook salmon in the chub fishery has declined substantially from about 8,000 in 1993 to less than 2,000 in 1999.

11. Twelve other species, in addition to lake trout and chinook, were captured incidentally in monitored lifts of commercial chub nets.

12. From January 1996 through June 1999, a total of 40 lifts of commercial large mesh gill net set for lake whitefish were monitored.

13. Lake trout CPEs in large mesh gill nets set on the bottom in the Lake, all years combined, were high at all depths monitored. Mean CPE in float nets in the Lake was lower in comparison. CPE was lowest in nets set on the bottom in Green Bay.

14. The majority of incidental lake trout in large mesh gill nets during 1996-99 were greater than 500 mm (20 inches), with most ranging in age from 4 to 7-years-old.

15. Overall lake trout mortality in large mesh gill nets at time of lifting in both areas was less than 50%.

16. The incidental CPE for chinook in large mesh gill nets was1.5 fish/1000 feet, substantially lower compared to lake trout CPEs in the same gear.

17. Most chinook captured in large mesh gill nets were less than 600 mm and ranged in age from 0 to 1+.

18. The estimated incidental kill of lake trout in large mesh gill nets increased substantially during 1998 and 99 compared to a much lower trend during most of the 1990s.

19. The estimated incidental kill of chinook in large mesh gill nets during the 1990s remained relatively low and stable, averaging about 3,900 fish annually, Bay and Lake combined.

20. In addition to lake trout and chinook, nine other fish species were caught incidentally in monitored lifts of large mesh gill net. Burbot and gizzard shad were the most abundant.

Appendix A. Summary of monitored commercial small mesh gill net effort targeted on chubs by grid and year.

GRID	1996	1997	1998	1999	TOTAL	PERCENT
506	0	2,400	0	0	2,400	0.1
607	0	14,600	26,000	7,000	47,600	2.5
608	0	16,800	46,400	8,000	71,200	3.7
706	0	4,800	0	0	4,800	0.3
707	0	99,900	78,300	24,000	202,200	10.6
708	0	0	8,400	0	8,400	0.4
1004	0	50,600	63,000	25,500	139,100	7.3
1005	40,000	162,500	98,500	10,500	311,500	16.3
1006	0	0	0	9,000	9,000	0.5
1104	10,500	15,000	63,500	27,000	116,000	6.1
1105	0	76,000	16,000	0	92,000	4.8
1204	0	12,000	42,000	0	54,000	2.8
1304	0	27,000	82,800	40,600	150,400	7.9
1403	0	0	11,700	0	11,700	0.6
1503	0	0	22,000	15,000	37,000	1.9
1504	0	61,600	68,000	10,000	139,600	7.3
1505	0	0	12,000	0	12,000	0.6
1602	0	0	31,200	0	31,200	1.6
1603	0	11,000	21,000	0	32,000	1.7
1702	0	0	12,000	0	12,000	0.6
1703	0	0	8,400	0	8,400	0.4
1704	0	0	32,400	0	32,400	1.7
1802	13,200	185,300	75,600	6,000	280,100	14.6
1902	0	46,800	9,600	0	56,400	3.0
1903	0	0	14,400	0	14,400	0.8
2003	0	12,000	0	0	12,000	0.6
2004	12,000	0	0	0	12,000	0.6
2005	0	0	18,000	0	18,000	0.9
2202	0	0	500	0	500	0.02
2203	0	0	5,000	0	5,000	0.3
TOTAL	75,700	798,300	866,700	182,600	1,923,300	100.52

Appendix B. Summary of catch rates of lake trout caught incidentally in monitored lifts of chub nets, by year, depth increment, geographic sampling area, and season. W – winter; SP – spring; S – summer; F – fall.

1996

DEPTH INCREMENT	NORTH CPE				MIDDLE CPE				SOUTH CPE				MIDLAKE CPE			
(feet)	W	SP	S	F	W	SP	S	F	W	SP	S	F	W	SP	S	F
0																
12																
24																
36																
48																
60																
90																
120																
150																
180																
210																
240																
270																
300												0.42				
330			0.21		0.17								2.25			
360			0.14						0.30							
390							0.00									
420							0.04									
450																
480																

1997

DEPTH INCREMENT	NORTH CPE				MIDDLE CPE				SOUTH CPE				MIDLAKE CPE			
(feet)	W	SP	S	F	W	SP	S	F	W	SP	S	F	W	SP	S	F
0																
12																
24																
36																
48																
60																
90																
120																
150																
180			0.22								1.93					
210																
240								0.42			173	0.39				
270	0.14			0.11			0.10	0.42	0.37			0.62				
300	0.13			0.21	0.62		0.00	0.15	1.17			0.17				
330	0.07			0.07	0.37		0.31					0.08				
360	0.07		0.00	0.00	0.12			0.10	0.13			0.33	0.00			0.00
390	0.02				0.02			0.03								
420	0.04				0.03											
450					0.03											
480					0.03											

Appendix B continued-

1998

DEPTH INCREMENT	NORTH CPE				MIDDLE CPE				SOUTH CPE				MIDLAKE CPE			
(feet)	W	SP	S	F	W	SP	S	F	W	SP	S	F	W	SP	S	F
0																
12																
24																
36																
48																
60																
90																
120										2.00						
150		3.85				0.83					0.89					
180		0.14				1.91	0.63			8.61	0.92					
210		0.18				1.19	0.89	1.22		2.20						
240			0.13			0.31	0.17					1.14				
270						0.15	0.09					0.54				
300	0.17	0.33	0.17	0.41		0.13	0.04	0.21				0.48				
330	0.26					0.10		0.15				1.01				
360			0.14	0.15	0.22	0.08		0.27	0.00	0.52			2.67	1.88		
390	0.13				0.06				0.08	0.47						
420					0.03											
450					0.06											
480					0.05	0.03										

1999

DEPTH INCREMENT	NORTH CPE				MIDDLE CPE				SOUTH CPE				MIDLAKE CPE			
(feet)	W	SP	S	F	W	SP	S	F	W	SP	S	F	W	SP	S	F
0																
12																
24																
36																
48																
60																
90																
120																
150																
180						0.60										
210						0.33										
240		1.22				0.04										
270																
300						0.03										
330																
360	0.10				0.13	0.13			0.23							
390					0.10	0.06										
420					0.01											
450																
480																

Appendix C. Summary of sample sizes (number of monitored lifts) used to calculate mean CPE by year, geographic sampling area, season sampling periods, and depth increment (feet). Abbreviations for seasons are: W – winter; SP – spring; S – summer; and F – fall.

1996 **Depth**	**NORTH**	W	SP	S	F	**MIDDLE**	W	SP	S	F	**SOUTH**	W	SP	S	F	**MIDLAKE**	W	SP	S	F
120																				
150																				
180																				
210																				
240																				
270																				
300															1					
330			1				2										1			
360			1									1								
390							3		1											
420									1											
450																				
480																				

1997 **Depth**	**NORTH**	W	SP	S	F	**MIDDLE**	W	SP	S	F	**SOUTH**	W	SP	S	F	**MIDLAKE**	W	SP	S	F
120										1										
150																				
180				1										2						
210																				
240										1				1	2					
270		1			2				1	1		7			3					
300		4			2		1		1	4		1			1					
330		2			2		13		2						1					
360		1		1	1		1			2		4			1				1	1
390		3					1			2										
420		1					2													
450							6													
480							2													

Appendix C continued-

1998 **Depth**	**NORTH**	W	SP	S	F	**MIDDLE**	W	SP	S	F	**SOUTH**	W	SP	S	F	**MIDLAKE**	W	SP	S	F
120													1							
150			1					1						1						
180			1					3	1				1							
210			1					2	3	2			1							
240				1				2	2						1					
270								3	4						1					
300		1	1	1	1			1	4	1					1					
330		5						1		3					1					
360				2	1		5	2		1		1	1				1	1		
390		1					5					1	1							
420							2													
450							1													
480							1	1												

1999 **Depth**	**NORTH**	W	SP			**MIDDLE**	W	SP			**SOUTH**	W	SP			**MIDLAKE**	W	SP		
120																				
150																				
180								2												
210								4												
240			1					1												
270																				
300								2												
330																				
360		2					1	1				1								
390							2	2												
420							1													
450																				
480																				

Appendix D. Total catch rates of lake trout by depth increment in commercial chub nets by survey area, pooled by season and year for each of three time periods: 1981-85, 1986-90, and 1996-99. Total catch rate (number of lifts).

NORTHERN AREA

DEPTH INCREMENT (FEET)	1981 - 1985	1986 – 1990	1996 - 1999
90			
120			
150	6.700 (8)	0.560 (6)	3.850 (1)
180	0.849 (35)	0.353 (24)	0.179 (2)
210	0.815 (45)	0.286 (19)	0.175 (1)
240	0.531 (31)	0.289 (11)	0.675 (2)
270	0.639 (18)	0.055 (19)	0.118 (3)
300	0.219 (13)	0.067 (15)	0.200 (10)
330	0.143 (10)	0.044 (11)	0.181 (10)
360	0.244 (4)	0.052 (6)	0.093 (9)
390	0.029 (5)	0.017 (6)	0.049 (4)
420	0.139 (1)	0.053 (4)	0.035 (1)
450			
480			

MIDDLE AREA

DEPTH INCREMENT (FEET)	1981 - 1985	1986 – 1990	1996 - 1999
90	0.095 (1)	0.225 (4)	
120	8.958 (1)	0.151 (10)	0.000 (1)
150	0.104 (2)	3.923 (4)	0.833 (1)
180	0.776 (31)	1.662 (30)	1.258 (6)
210	0.417 (54)	0.307 (18)	0.801 (11)
240	0.441 (19)	0.109 (29)	0.234 (6)
270	0.250 (12)	0.126 (13)	0.156 (9)
300	0.161 (6)	0.073 (19)	0.126 (14)
330	0.184 (5)	0.015 (24)	0.280 (21)
360	0.550 (2)	0.033 (18)	0.148 (13)
390	0.024 (1)	0.031 (12)	0.053 (16)
420	0.195 (3)	0.008 (4)	0.031 (6)
450	0.000 (1)	0.004 (4)	0.031 (7)
480		0.021 (1)	0.034 (4)

Appendix D continued-

SOUTHERN AREA

DEPTH INCREMENT (FEET)	1981 - 1985	1986 – 1990	1996 - 1999
90			
120	2.024 (8)	0.198 (1)	2.000 (1)
150	0.664 (29)	2.014 (4)	0.885 (1)
180	1.086 (46)	0.456 (5)	3.350 (4)
210	0.650 (46)	0.488 (18)	2.200 (1)
240	1.179 (17)	0.256 (8)	0.909 (4)
270	0.964 (19)	0.862 (10)	0.454 (11)
300	0.743 (23)	0.321 (6)	0.559 (4)
330	0.312 (4)	0.230 (8)	0.548 (2)
360	0.109 (6)	0.187 (7)	0.211 (9)
390	0.050 (3)	0.100 (1)	0.276 (2)
420	0.126 (1)	0.000 (1)	
450		0.000 (3)	
480		0.000 (3)	

MIDLAKE AREA

DEPTH INCREMENT (FEET)	1981 - 1985	1986 – 1990	1996 - 1999
90		0.069 (1)	
120	0.833 (1)	0.114 (5)	
150			
180	1.075 (2)	0.200 (1)	
210	1.308 (14)		
240	3.005 (22)		
270	2.811 (19)	1.949 (7)	
300	0.757 (13)	1.969 (9)	
330	0.893 (3)	0.509 (5)	2.250 (1)
360	0.033 (1)	0.861 (1)	0.937 (5)
390	0.025 (1)	0.000 (1)	
420	0.122 (1)	0.253 (1)	
450			
480			

Appendix E. Summary of gill net effort reported by year and area for lake whitefish and chubs. Effort in 1000s of feet; LMGN = large mesh gill net and SMGN = small mesh gill net; WM2 and NORTH = northern Green Bay; WM3 = northern chub zone; SOUTH = southern chub zone.

	GEAR LOCATION AND TARGET SPECIES			
YEAR	LMGN (WM2)	LMGN (WM3)	SMGN NORTH	SMGN SOUTH
	WHITEFISH	WHITEFISH	CHUBS	CHUBS
79	24,188.0	5,282.0		12,677.2
80	16,176.0	4,059.0		21,811.6
81	14,697.0	6,768.0	4,920.4	18,095.6
82	14,400.0	7,643.0	3,469.8	16,032.6
83	9,324.7	6,392.7	6,924.7	19,490.0
84	11,884.0	4,870.0	6,148.4	30,868.7
85	12,202.7	2,371.6	3,210.0	32,791.1
86	12,847.3	4,157.7	7,037.2	34,606.1
87	15,544.2	6,066.1	6,968.6	32,373.9
88	11,549.2	7,139.6	8,382.3	58,439.0
89	8,172.4	4,820.0	8,280.8	48,218.1
90	5,391.5	2,914.5	8,226.4	41,397.4
91	4,322.5	1,883.2	9,453.5	45,288.3
92	5,384.7	2,787.6	11,453.1	40,483.7
93	5,203.7	1,956.2	15,973.6	42,669.8
94	2,989.8	1,229.0	8,176.2	35,085.5
95	3,115.5	1,109.7	5,326.4	28,844.9
96	2,351.7	916.3	4,589.7	27,616.6
97	4,060.7	1,380.3	4,365.6	28,441.8
98	3,547.9	5,259.2	3,029.0	23,921.1
99	1,660.3	6,109.4	1669.7	25,253.2